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Recent advances of feed-in tariff in Malaysia

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ABSTRACT

In order to promote the growth of renewable energy sector in Malaysia, feed-in tariff (FiT) mechanism has been introduced by Malaysian government in 2011, in accordance with Renewable Energy Act 2011 and Sustainable Energy Development Authority Act 2011. The tariff was enacted to overcome the shortcomings identified in the small renewable energy power (SREP) Program from 2001 to 2010. This paper highlighted some measures adopted to rectify the shortcomings identified during SREP, and the role of Sustainable Energy Development Authority (SEDA) in achieving the above mentioned task. The paper also includes the latest progress on renewable energy projects, especially those related to solar photovoltaic system. It is predicted that solar energy will become the main source of renewable energy in Malaysia by the year 2050.

Contents

1. Introduction

Since the advent of human civilization natural sources, sunlight and woods are the chief sources for energy for man. On the other hand, domesticated animals were the common means of transportation. However, with the emergence of Industrial Revolution around 1760, the need for more powerful, reliable and abundant energy propelled the need for finding alternatives of storing and transporting the excess energy acquired. Since 1859, when petroleum surfaced, coal was gradually replaced as the main source of energy, especially after the invention of internal combustion engine to power vehicles [1]. With the success of petroleum production technologies, almost all aspects of human daily lives, such as power generation, petrochemicals production and

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transportation was dominated by petroleum-based products, including plastics, soaps and fertilizers to mention just a few. Due to these petroleum related activities, the consumption of petroleum is increasing at an alarming rate. As a result, the hitherto assumed inexhaustible petroleum resources is now depleting at an astronomical rate. Furthermore, the production of energy from petroleum is associated with the release of carbon dioxide gas into the atmosphere, which is the principal cause of global warming. International Energy Agency (IEA) has identified this as the biggest environmental challenge caused by human beings due technological advancement., hence various steps have been taken to decrease the dependency on crude oil as the primary energy source [2]. One of the steps includes 2 °C scenario (2DS), which aims to limit the rise of global temperature in 2 °C, instead of 6 °C if no preventive measures have been taken, by 2035 [3], This can be done by promoting renewable energies in replacement of the crude oil. By harnessing energy from natural and non-depleting sources (including sun, wind, hydro, geothermal heat under the ground, and others), the emission of CO_2 released from utilization of crude oil can be reduced.

Currently, IEA is made up of 28 countries, but apparently most nations across the globe understand the importance of renewable energies, and are making concerted effort to promote its development in their respective countries and Malaysia as a sovereign nation is not left behind in this crusade. Malaysia, like most of the countries, has been relying on crude oil and natural gas as the main energy supply, especially in the electricity sector. It was recorded that the primary energy demand of Malaysia increased from 21,471 thousand tons of oil equivalent (ktoe) in 1990 to 79,289 at 2011, and 79% of the demand in 2011 consist of natural gas, crude oil and petroleum products, as shown in Fig. 1 [4]. In the past, Malaysian government has been heavily subsidizing the power sector in terms of the price of natural gas used. However, following the country's rapid development, more subsidies have to be put into the power generation. Hence, Malaysian government is shifting the power generation into the utilization of renewable energies to reduce the economic burden.

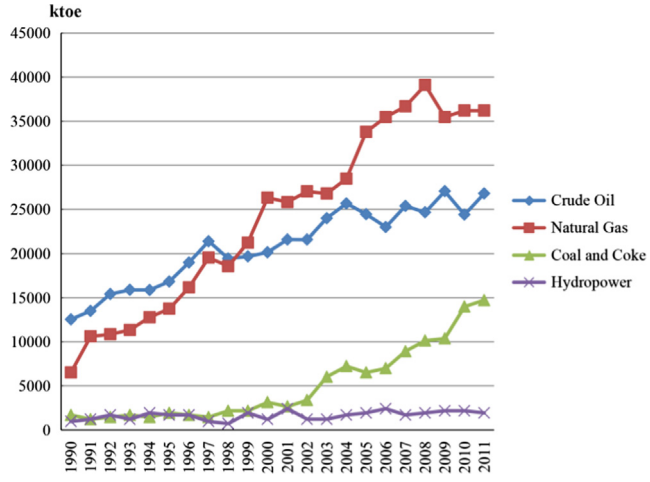

Fig. 1. Malaysia energy demand by types of fuels [4].

Table 1
Renewable Energy connected to grid as of May 2011 (*Source*: Ministry of Energy, Green Technology and Water (KeTTHA)).

Category	Capacity (MW)
Biomass	40
Biogas	4.95
Small hydro	12.5
MSW	5
Solar PV	2.5
Total	64.95

Several studies have been conducted on the energy development in Malaysia. For example, Chua and Oh [5] reviewed on the important agencies and programs in Malaysian energy development since its dependence, while Ahmad et al. [6] discussed energy demands and potentials of several renewable energies (RE) in Malaysia. Similar review was also done by Hashim and Ho [7]. On the other hand, Mekhilef et al. [8] and Muhammad-Sukki et al. [9] gave specific attention to the development of solar energy in Malaysia. An extensive review was also done by Chua et al. [10] on feed-in tariff (FiT) mechanism, which was implemented since November 2011. This paper will discuss the latest development of the FiT mechanism in Malaysia, especially how it rectified the shortcomings identified during SREP program, as well as its role in stimulating the growth in the renewable energy (RE) sector in Malaysia, with the special focus on solar energy sector.

2. Background of RE sector in Malaysia

Malaysian government has been promoting RE since its independence, by introducing several policies and acts as follow:

a. National Petroleum Policy (1975).
b. National Energy Policy (1979).
c. National Depletion Policy (1980).
d. Fourth Fuel Diversification Policy (1981).
e. Electricity Supply Act (1990).
f. Gas Supply Act (1993).
g. Fifth Fuel Policy (2000).
h. Energy Commission Act (2001).
i. National Biofuel Policy (2006).
j. National Green Technology Policy 2009.
k. Renewable Energy Act 2011.
l. Sustainable Energy Development Authority Act 2011.

The policies and acts from (a) to (k) have been reviewed by several researchers [5,7,9–12]. It is noted that the Malaysian government started to recognize the potential of renewable energies by replacing fossil fuels to provide electricity in the country. Thus, it is listed as the fifth fuel in Malaysian energy supply mix in 2000. Countless efforts have been initiated to produce renewable energies in Malaysia. Thus, Small Renewable Energy Power (SREP) Program was launched on the 11th May 2001. The objective of SREP was to encourage the participation of private sectors in the RE sectors, and the possible sources recognized under this program including solar, biomass, biogas, wind, and mini-hydro energy. The RE developers can sell the generated electricity to utility suppliers, such as Tenaga Nasional Berhad (TNB) in West Malaysia, or Sabah Electricity Sendirian Berhad (SESB) in Sabah. The electricity is then sold to end-users through the National Grid. It is noted that this program was not applicable in Sarawak due to its own legislation in electricity supply. In order to participate in SREP, developers are required to negotiate directly with the utilities regarding the Renewable Energy Power Purchase Agreement (REPPA), including the selling price of the electricity, based on a "willing seller, willing buyer" model. Once the plant is commissioned, the developers would be able to obtain license for the plant operation of 16–21 years, depending on the types of RE source used.

Despite of the high expectation (500 MW) when SREP was launched, from 2001 to 2005, only 12 MW of RE from two projects

went on-grid. The failure of the program to achieve its target indicated the presence of certain drawbacks in the program. Upon revision, SREP program was extended until 2010, with the target reduced to 350 MW. At the end of the program, roughly 64.95 MW of RE was connected to the national grid (as shown in Table 1), which again indicated the incapability of the program in promoting RE in Malaysia to replace by 100% the conventional fossil-based electricity generation.

In order to determine the factors that caused the failure of the program, a study was done by Sovacool and Drupady [12]. The study involved visits to 38 institutions that were involved in the SREP program, including:

a. Engineering and consulting firms,
b. Government and regulatory agencies,
c. Energy companies and utilities, and;
d. Research institutes, civil society organizations, and trade organizations.

Interviews were also conducted on the key persons in the institutions during the visits. From the outcome of the observations and interviews, several limitations of SREP program were identified, which is discussed in Section 5.

3. Feed-in tariff

Due to environmental degradation as a result of continuous use of fossil fuels, many countries started the process of developing green energy that is based on renewable sources. However, the high cost on research and development of RE sector made it hardly economically justifiable. Hence, at the initial response of to the RE sector development by private organizations was lackadaisical. Therefore, most developers had to be subsidized by their respective governments of their countries in the form of incentives and enabling policies.

The first FiT was introduced in 1978 when the US president at that time, President Jimmy Carter, signed on the National Energy Act [13]. In 1990, Germany adopted "Stromeinspeisungsgesetz" (StrEG) Law, which meant "Law on Feeding Electricity into the Grid". In 2000, StrEG law was amended to form German Renewable Energy Act (GREA) (German: Erneuerbare-Energien-Gesetz, EEG). At the initial stage when StrEG and GREA were established, there are some concerns raised regarding the effect of FiT towards the economy of Germany [14], due to lack of clear cut policies regarding the program. Some of these concerns included:

1. The distribution of the extra-high installation cost of PV modules to electricity consumers, which included government, companies and individuals, for nearly 20 years. Although this regulation guarantees the profit of the solar energy developers, it possesses high cost per unit of electricity to the end-users. The heavy subsidy drained much budget that could be used on other potential energies forms.
2. The effectiveness of solar energy was questioned, as the contribution of solar power towards total national electricity demand does not match the incentive given. For example, according to a study [14], electricity generated from solar energy in 2010 was only around 14.5% of the green electricity production in Germany, but 38.6% of the subsidy was spent on PV at the same year. In comparison, wind energy supported 46.4% of the green energy production, with merely 25% of the subsidy from the tariff.
3. The installation and operation cost of a technology is always high at its initial stage. Thus, higher subsidy is required for its substantial growth. However, following the advances in the technology of the process, there is a cost reduction related to the technology. Thus, the subsidy given to the developers of solar energy has to be reduced to match its new current production cost, to the suffering of the consumers due to the cost of electricity generated form the process. In addition, when the tariff is higher than the actual cost of solar energy production, more companies are encouraged to invest in PV sector in order to seek extra profit that is derived from it. When adjustment on the tariff is made regarding PV development, some companies discovered that their expected profit is reduced, and might not even match the current production cost. Thus, it is always the responsibility of the regulatory body to have tariff revision on a timely basis, to ensure that all parties involved, including consumers, government, RE developers, receives fair treatments.
4. The subsidy in solar PV sector was aimed to stimulate the penetration of solar energy into the market, while the more important issue, which is technology improvement that leads to cost reduction of the technology, has been put aside. However, the debate still out on whether intensive reduction in the cost related to the technology caused high market penetration, or the reverse is true.

In order to solve the problems that arose, improvements and law amendments had been done by Germany [15,16]. With improved policy, Germany experienced a rapid growth in RE sector, especially in solar PV [17]. Although there are many other mechanisms and policies that are designed and adopted to stimulate the renewable energy development, comparisons of different sources indicated that FiT is currently the most successful policy framework in promoting the growth of RE sector [18,19], hence it is was benchmarked by other countries in considering the application of FiT. For example, Ontario, which is a state in Canada, introduced the FiT mechanism in 2009, and the result was compared to that of Germany by Mabee et al. [17]. In both cases, the rates offered to the RE developers were similar, except that the Ontario offered higher rate than Germany for solar PV. However, after 5 years of implementation, it was found that FiT mechanism did not produce significant changes to the RE industry. Although the first round of FiT mechanism successfully induced the interest of developers in electricity production from RE sources, there was no long term plan for the developers to develop the program. In addition, the lack of enabling policies to support the Ontario program like EEG was identified to be another reason of slow growth in FiT mechanism. Furthermore, there was less attention given to the e FiT by Ontario when compared to Germany, thus reducing the available alternatives for potential investors. As a result, the RE portfolio in Ontario generating capacity was limited to three technologies, which were wind, biomass and solar PV. It was also pointed out that the use of degression factor would be a better choice over the escalation factor currently applied by Ontario, as billions could be saved over the course of the program.

Thailand is the first ASEAN country to implement well-planned FiT mechanism. In 2011, 10-Year Alternative Energy Development Plan (AEDP) replaced the previous RE plan, namely, 15-Year Renewable Energy Development Plan (REDP) (2008–2022), in promoting the growth of RE sector. The target of REDP was to increase the share of RE to 20% of national energy consumption. As other renewable energies are still on their developing stages, that of solar energy production was achieved in year 2011 [20]. Under this mechanism, Adder Program was set up to guarantee attractive purchasing rates for electricity from renewable source. Besides that, easily comprehensible structure in FiT mechanism, as well as secured contract that prompted trust from the developers towards the profitability of their projects, ensured the successful implementation of the FiT mechanism. Despite of the sound foundation of the mechanism, limited supervision by weak regulatory agencies was identified as a constraint towards the

success of the mechanism. Moreover, there are six separated national energy plans in Thailand, and each of these plans is supervised by different government body which presented lack of proper coordination. This presented difficulty towards Adder Program to effectively provide continuous support to all national plans at the same time. In order to make sure all types of RE meet their targets by 2021, all these problems have to be tackled.

Philippines and Indonesia also implemented FiT mechanism since 2008 and 2009 respectively to encourage the green energy production, as well as reduce carbon emissions. However, the mechanism is less effective in these countries, due to the several issues identified [21]. In Philippines, the planning and implementation of FiT mechanism is heavily dependent on the political scenario in the country. Due to these issues Renewable Portfolio Standard, which is supposed to be the new law to guide the development of RE sector, has yet to be passed. This created the uncertainties to the potential investors. In addition, investors cannot estimate their profits when entering the RE sector in both countries, due to the lack of important criteria in the FiT mechanism, namely the rates, periods of payment, as well as the degression rate. In order to put FiT mechanism into effective action in Philippine and Indonesian, careful planning by the regulatory bodies from the government is vital. Other than the countries discussed above, there are many countries that are currently adopting FiT mechanism, due to its effectiveness in promoting RE sector. Taiwan implemented FiT mechanism in 2009 [22], and the tariff rates was revised in 2011 to catch up with the latest market price. Although it is too early to discuss on its effectiveness towards the growth of RE sector in Taiwan, a case study was performed to examine the mechanism at its planning stage [23]. Moreover, 12 countries in Latin America and Caribbean region adopted FiT mechanisms in 2010 [24]. There are many countries that are currently planning to implement FiT, including China [25,26], the major producer of PV modules in the world, as well as Singapore [27] and Brunei [28].

4. FiT mechanism in Malaysia

The idea of FiT mechanism was introduced by the Malaysian government under National Renewable Energy Policy and Action Plan (2010). Malaysia's FiT mechanism is currently implemented by Ministry of Energy, Green Technology and Water (KeTTHA) via the Sustainable Energy Development Authority, Malaysia (SEDA Malaysia). FiT mechanism is defined as the mechanism that allows electricity produced from indigenous RE resources to be sold to power utilities at a fixed premium price and for specific duration [29]. The objectives of FiT mechanism are [30]:

Objective 1: To increase RE contribution in the national power generation mix;
Objective 2: To facilitate the growth of the RE industry;
Objective 3: To ensure reasonable RE generation mix;
Objective 4: To conserve the environment for future generation; and
Objective 5: To enhance awareness on the role and importance of RE.

In order to achieve the objectives, 5 strategic thrusts (ST) have been set, which are described in detail in National RE Policy 2010 [31]:

ST 1: Introduce legal and regulatory framework.
ST 2: Provide conducive business environment for RE.
ST 3: Intensify human capital development.
ST 4: Enhance research and development.
ST 5: Create public awareness and policy advocacy programs.

Table 2
Feed-in tariffs in Malaysia in 2013 [32].

Renewable energy	FiT rate			Annual degression (%)
	Effective period	(RM/kW h)	(USD/kW h) *0.31	
Biogass				
< 4 MW	16	0.32	0.099	0.50
4–10 MW	16	0.30	0.093	0.50
10–30 MW	16	0.28	0.087	0.50
Bonus of > 40% electrical efficiency	16	+0.02	0.006	0.50
bonus of local technology	16	+0.01	0.003	0.50
Bonus for landfill or sewage gas	16	+0.08	0.025	1.80
Biomass				
< 10 MW	16	0.31	0.096	0.50
10–20 MW	16	0.29	0.090	0.50
20–30 MW	16	0.27	0.084	0.50
Bonus for gasification technology	16	+0.02	0.006	0.50
Bonus for > 14% efficiency	16	+0.01	0.003	0.50
Bonus for local technology	16	+0.01	0.003	0.50
Bonus of use of MSW as fuel source	16	+0.10	0.031	1.80
Small hydro				
< 10 MW	21	0.24	0.074	0
10–30 MW	21	0.23	0.071	0
Solar photovoltaic (PV)				
< 4 kWp	21	1.23	0.381	8
4–24 kWp	21	1.20	0.372	8
24–72 kWp	21	1.18	0.366	20[a]
72 kWp–1 MWp	21	1.14	0.353	20[a]
1–10 MWp	21	0.95	0.295	20[a]
10–30 MWp	21	0.85	0.264	20[a]
Bonus for in-building installation	21	+0.26	0.081	8
Bonus for use as building materials	21	+0.25	0.078	8
Bonus for local solar PV modules	21	+0.03	0.009	0[a]
Bonus for local solar inverters	21	+0.01	0.003	0[a]

[a] The new proposed degression rate was announced on 26th February 2013. It came into effect on March 2013, and applicable to quotas released in 2013.

Table 3
Prevailing displaced cost in East and West Malaysia (*Source*: SEDA Malaysia).

RE connection point	Prevailing displaced cost (RM/kW h)	
	Peninsular Malaysia	Sabah and Labuan
Medium voltage (1–50 kV)	0.1900	0.1900
Low voltage (≤ 1 kV)	0.2641	0.2641

Currently, the technologies that are listed under the FiT mechanism are biomass (including solid waste), mini-hydro, solar photovoltaic (PV) and biogas (including landfill and sewage). These energy sources are proven to be practically viable in Malaysia [10]. At the moment, the potential of wind energy and geothermal energy as RE sources in Malaysia are yet to be harnessed by Ministry of Science, Technology and Innovation, as well as Ministry of Natural Resources and Environment, respectively. Once their potentials have been identified, possible amendments will be made in Renewable Energy Act 2011 to include them

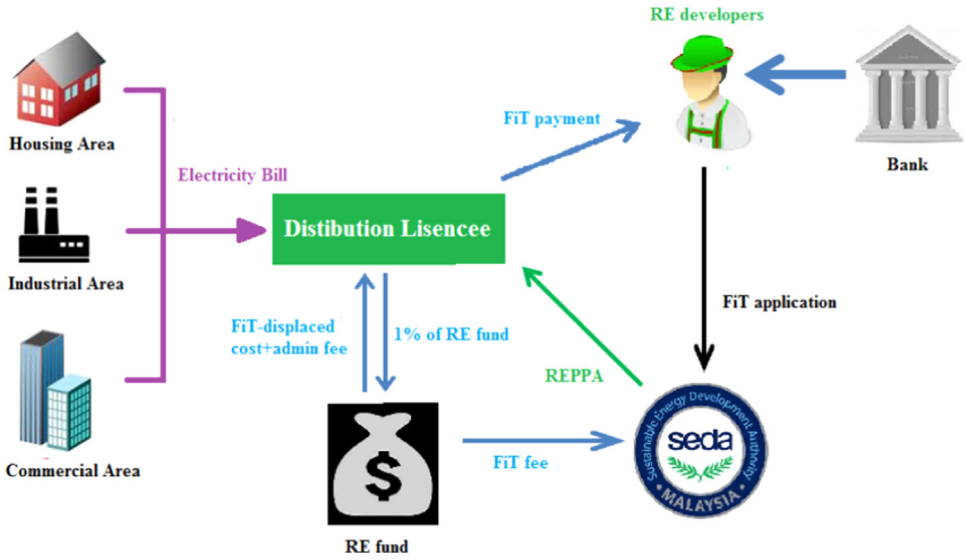

Fig. 2. Connections of different agencies and types of payment involved in FiT mechanism [29].

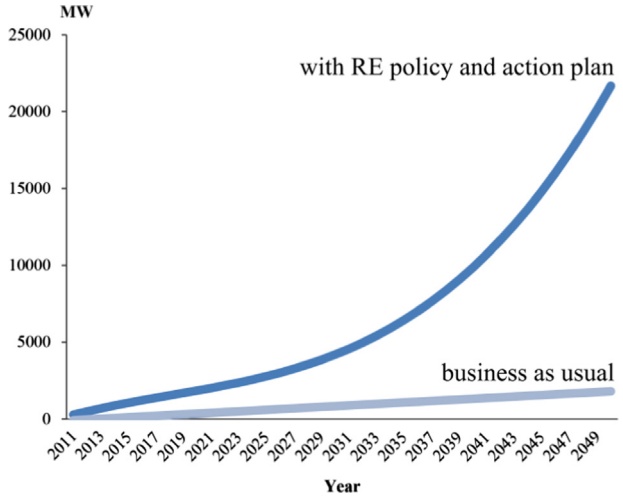

Fig. 3. Goals of Renewable Energy Acts and Policy [33].

(Source: KeTTHA). It is expected that in the near future, the overall cost for a particular RE technology will decrease gradually as its technology is becoming easier and cheaper. On the other hand, the existing subsidy for fossil fuel in electricity generation will be slowly removed, which leads to fair competition between energy from fossil fuel and RE sources. When the overall rise in the cost of electric generation from renewable sources is the same to that from fossil fuels, grid parity is achieved. Currently, RE developers are paid by the Distribution Licensee (TNB or SESB) for the generated electricity, according to the price listed in Table 2. Once the grid parity is achieved, RE developers will be paid based on the prevailing displaced cost for the remaining period of REPPA. The displaced cost is defined as the average cost to supply 1 kW h of electricity from non-renewable resources to the point of interconnection with the installation of RE. The prevailing displaced cost is listed in Table 3. However, it is subjected to revision when required.

Malaysia is different from other countries by introducing the capping of the FiT. Its objective is to ensure that RE Fund, the sole funding source for FiT, is sufficient to pay for the electricity from renewable sources. Currently, the FiT fund source is limited to 1% of the revenue from electricity sold to end-users imposed on the utility's electricity revenue [32]. The electricity consumers are responsible to contribute the corresponding amount to the RE Fund, but those who consume less than 200 kW h/month are exempted from the contribution. Once the electricity market in Malaysia is deregulated, or when FiT operation is established, the removal of the caps would be considered. The important information regarding FiT mechanism is illustrated in Fig. 2 [29].

It is estimated that through this mechanism, RE generation can be increased to 5.5% of the total electricity supply by 2015 [32], together with 40% carbon emission intensity reduction by 2020. There would be a significant increase of RE production, especially from 2030 to 2050. The significant increase is expected to come mainly from solar PV (as shown in Fig. 3), and this will occur largely due to the RE Policy and Action Plan in Malaysia.

In order to promote the generation of RE in Malaysia, the developers are entitled to several incentives, including [34]:

1. Pioneer status with income tax exemption 100% of the statutory income for 10 years; or
2. Investment Tax Allowance (ITA) of 100% on qualifying capital expenditure incurred within a period of 5 years. This allowance can be set-off against 100% of statutory income for each year of assessment; and
3. Import duty and sales tax exemption on equipment used to generate energy from sources not produced locally and sales tax exemption on equipment purchased from local manufacturers.

(It is noted that the application of incentives above is extended to 31st December 2015, *Source*: SEDA Malaysia).

Other than RE sector, it is expected that there would be socio-economic impacts brought by FiT mechanisms to Malaysia by 2020, which include [32]:

1. Creation of 52,000 jobs in RE sector.
2. RM 70 billion of revenues from RE business, hence RM 1.75 billion of income tax to the government.
3. RM 19 billion worth loans for RE developers, hence providing a source of income to banks.
4. Prevention of 42 million and 145 million tons of CO_2 emitted from power generation sector in 2020 and 2030, respectively.

5. Savings of RM 2.1 billion in external cost to mitigate CO_2 emissions from 2011 to 2020.
6. Improve the image of Malaysia and its government as being responsible to address the issues of climate change.

5. Roles of Renewable Energy Act 2011 and SEDA Malaysia in FiT mechanism

Renewable Energy Act 2011 was gazetted on 2nd June 2011 as a guideline in setting up the FiT system, to ensure the smoothness of REPPA purchase and handling of RE fund. Through Renewable Energy Act 2011, several criteria have been guaranteed to the RE developers [35]:

1. Electricity access to the nation's grid.
2. Clear application and approval procedures.
3. FiT tariffs are high enough to produce reasonable investment return and profit, while being fixed for certain period to protect the RE business.
4. RE developers can be paid from adequate funding throughout the contract period.
5. Implementation of the related policies by a competent agency.

In order to effectively stimulate the growth in RE sector in Malaysia, a statutory body was formed under the Sustainable Energy Development Authority Act 2011, namely Sustainable Energy Development Authority Malaysia (SEDA). The responsibilities of SEDA are listed below [36]:

- To advise the Minister and relevant government entities on all matters relating to sustainable energy.
- To promote and implement the national policy objectives for RE;
- To promote, stimulate, facilitate and develop sustainable energy;
- To implement, manage, monitor and review the FiT system;
- To implement sustainable energy laws and to recommend reform of such laws to the Federal Government;
- To promote private sector investment in the sustainable energy sector;
- To carry out or arrange for the conduct of researches, assessments, studies and advisory services, collate, analyse and publish information, statistics and factors influencing or relevant to the development of sustainable energy;
- To conduct, promote and support research and innovation activities related to sustainable energy;
- To conduct, promote and support training or other programs related to the development of human resources and capacity building in the sustainable energy sector;
- To implement measures to promote public participation and to improve public awareness on matters related to sustainable energy;
- To act as the focal point to assist the Minister on:
- Matters related to sustainable energy; and
- Climate change matters related to energy.

6. Steps taken in Malaysian FiT mechanism to solve the problems in Small Renewable Energy Power (SREP) Program

Despite discouraging results from SREP program, Malaysian government continues the efforts in promoting the development of RE. The FiT mechanism that was launched in 2011 addressed several issues which were identified by Sovacool and Drupady [12] during the SREP. The following subsections represent the efforts made to overcome the issues.

6.1. Low tariffs for RE generation

The concept of FiT has been implemented since 2001 when the SREP program was introduced. However, the tariffs rate was far too low in the opinions of most RE developers at that time. The profit earned by the RE facilities through the sale of electricity was barely enough to maintain the operation of the facility. As a result, most facilities have to find other alternatives to support the operation costs. For example, one of the energy developers from biomass had to depend on tipping fee, production of plastic resins from waste, and recycling of drinking cans to support the plant operation. Some other developers had to obtain carbon credits in Clean Development Mechanism (CDM) to survive in the market of RE. A more embarrassing situation occurred when the FiT was created to encourage the sale of electricity to National Grid, but developers often find other profitable alternatives to sell their energy or products.

Due to this issue, the tariffs have been revised in 2006 and 2007, as shown in Table 4 [12]. However, the revision was done only on biomass and biogas sectors, while other sectors, such as wind energy, remain unchanged. This was described by some RE developers as an unwise decision.

Considering the importance of the tariffs to stimulate the growth in RE sector, new tariffs have been calculated and enforced in FiT mechanism. According to the Renewable Energy Act 2011, the tariffs given to a particular technology differ according to the facilities capacity. Extra bonus is also given to the facilities for using local technology, as well as for those achieving high efficiency in electricity generation. The new tariffs are expected to produce enough return on investment in RE facilities, hence reducing the economic burden on the developers. The FiT given to a developer is fixed for the next 16 or 21 years, depending on the type of technology used until grid parity is achieved.

In order to ensure that the tariffs adopted reflect the true cost of technology used, SEDA Malaysia adapts the Levelized Cost of Energy (LCOE) metric, which is adopted by most agencies and institutions for the same purpose. The metric covers overall costs of the system, both investment and operational. Workshops were regularly organized to engage the stakeholders in the revision of the tariffs to suit the latest RE development in Malaysia, as well as the progression of global RE technology.

6.2. Capping of the tariff

During the SREP program, the fund that was used to subsidize the RE sectors originated solely from government fund. However, it was realized when several countries adopted similar mechanism to stimulate the growth in RE sector, failures in sustaining the RE growth were reported due to the limitations of funding needed. In order to prevent the Malaysian RE fund from declining, capping of

Table 4
Comparison of tariffs in SREP program and FiT mechanism [12].

RE	Prices during SREP (RM/kW h)			FiT (2011) (RM/kW h)
	2002	**2006**	**2007**	
Biomass	0.17	0.19	0.21	0.27–0.45
Biogas	0.17	0.19	0.21	0.28–0.43
Mini-hydro	0.17	0.17	0.17	0.23–0.24
Solar	–	–	–	0.85–1.78

10 MW had been set on the capacity generated in each facility. Although the facilities with more than 10 MW of capacity were allowed, only 10 MW of electricity could be sold to the end-users. However, the developers saw it as a limitation to the RE development. Many projects that can go big originally had been capped to be small scale, which is stated in the "Small Renewable Energy Program". When the facility was limited to the mentioned capacity, the portion of starting fee, miscellaneous costs involved (including starting cost, procedure payments, interconnection fee, etc.) became large when compared to the expected profit.

With the introduction of Renewable Energy Act 2011 [35], the new FiT has increased the cap to 30 MW. Thus, facilities with higher capacity now can sell more to the electricity utilities, hence gain more profit. However, when considering that the cost in electricity generation decreases with the capacity, the tariff for a particular technology decreases with the amount of plant capacity. The use of more than one plant, or more than one energy source in a particular facility is also allowed now, hence increasing the flexibility in the possible plant expansion.

The issue of limited funding for subsidy in form of tariff was also solved with the set-up of RE Fund. Renewable Energy Act 2011 stated that the end-users that used more than 300 kW h/month has to pay 1% of their bills to the RE fund, effective on 1st December 2011. This was expected to generate RM 300 million by the end of 2013 [37]. With the addition to the initial RM 300 million funding from the governments, the RE fund now should be more than sufficient to assist the developers despite the increase in capping. According to the planning, the collection of RE funding will end at 2030, and the remaining fund will be able to support the existing REPPA until 2048. Grid parity will occur by that time, and the FiT mechanism ends.

6.3. Resistance from certain organizations

When SREP program was enforced, the Ministry of Energy, Green Technology and Water established a Special Committee on Renewable Energy (SCORE) to monitor the program and handle the projects application. However, many problems were reported by the developers during this process [12]. A lot of precious time was spent during the negotiation of REPPA, because SCORE only met once in every six months to decide and approve all the SREP projects. This means that a project had to go through repeated half year cycles of "disapprove-improvement-waiting" until it is approved.

On the other hand, TNB was observed to have the monopsony power during the negotiation process. As TNB is the sole electricity distributor to users in Peninsular Malaysia, the development of RE became a threat to its business. Therefore, low tariffs were given to the RE developers, together with strict performance checking. Furthermore, several applications from developers to increase the capacity had been declined by TNB. In addition, SCORE committees consist of Malaysian Palm Oil Board (MPOB) and TNB representative, and resulted in the conflict of interest in the decision-making process. The examples included:

- Direct benefits to palm oil mills represented by MPOB by setting the RE price at RM 0.21/kW h, and;
- The standardization of REPPA for RE plants under 2 MW enabled TNB to exercise its monopsony power in negotiation of REPPA for RE plants above 2 MW.

In short, there were too many uncertainties to deal with in the effort to develop RE. According to the statistics, there were 50 projects with a total capacity of 288 MW being approved from 2001 to 2008, but only 2 projects, which equals to 13 MW, were successfully built. In addition, one-third of the approved projects never started their operations.

The enactment of Renewable Energy Act 2011 protects the bargaining power of RE developers when dealing with distribution licensees such as TNB. They have to purchase the RE from the developers, and prioritize such purchases over non-renewable energy. Penalties will be levied on them if there is a failure to purchase RE. Together with the fixed tariffs, the return of the investment should now be protected from part of the existing uncertainties.

Malaysian government has taken advanced steps to ensure that the FiT mechanism can run smoothly, with the introduction of e-FiT Online system. It is an intelligent system that ensures transparency, good governance and openness of the FiT application, where the quota for RE applications can be done based on a first-come-first-served basis. Possible human interventions during the applications can then be avoided. The integrated e-Fit Online system also performs quota balancing, monitoring and reporting modules to ensure immediate updated information to parties and individuals involved in the application. SEDA Malaysia is also able to monitor the progress of all approved project through this system, and immediate actions will be taken on the Feed-in Approval Holders (FiAHs) that fail to meet the project milestones to ensure the fairness to other developers and applicants [38]. Tutorials and workshops were organized to the applicants for them to familiarize with the system before they applied the scheme, hence reducing the probability of errors during the process. With e-FiT Online system, potential developers can now do the online application, and the successful application will be notified instantaneously. However, the approval is subjected to the quota given to each category of technology each year.

In order to produce effective communication between SEDA Malaysia and potential developers, a SEDA website was set up since its inception. All the information and updates regarding FiT mechanism can be found in the website. Press releases regarding public opinions on the policy can also be found.

6.4. Numerous application procedures involving different government bodies

In the effort to develop RE energy, the applicants need to get approvals from the state government. Although there was no study on this matter, the application can be lengthy for normal procedure. Renewable Energy Act 2011 does not apply to State issues, but SEDA is willing to liaise between the RE developers and State government to expedite the process. This definitely smoothen the application process and save the hassles of the developers.

6.5. Difficulties in getting financial assistance from local banks

As the field of RE is still new to local market during SREP program, most banks did not understand the concepts of RE projects during the applications. Thus, the developers were unable to get the financial support from the banks. Some of them went to Chinese and Japanese finance organizations for the support. In order to solve this problem, SEDA Malaysia is trying to engage local banks in providing financial aids to the RE project developers. Several steps had been taken to address the issue, which include the setting up of Green Technology Financing Scheme (GTFS) that provided financial aids of RM 1.5 billion to RE developers and users from 1st January 2010. Companies were required to submit proposals for technical evaluation by Malaysian Green Technology Corporation (MGTC). Once passing the evaluation, the companies might apply for financial aids from participating financial institutions. Government bore the 2% interest rate of the loans, and 60% of the financing approved amount was guaranteed by the government [39]. Several features of GTFS are illustrated in Table 5 [39].

Table 5
Features of GTFS [39].

Features	Producers of Green Technology	Green Technology users
Financing size	Maximum of RM 50 million/company	Maximum of RM 10 million/company
Financing tenure	15 years	10 years
Aim of financing	To finance investments in green technologies production that meet Scheme objective	To finance investments in green technologies utilization that meet the Scheme objective
Eligible criteria	Legally registered Malaysian-owned companies (at least 51%) in all economic sectors.	Legally registered Malaysian-owned companies (at least 70%) in all economic sectors.
Participating financial institutions (PFIs)	All commercial and Islamic Banks; Development financial institutions (Bank Pembangunan, SME Bank, Agrobank, Bank Rakyat, EXIM & Bank & Bank Simpanan Nasional)	

In 2013, more financial aids from the local banks in Malaysia have been obtained. Some of the banks have launched the financing packages, which are:

- Launching of a new solar photovoltaic (PV) financing package by Alliance Bank on 10th June 2013 to encourage the installment of solar PV system at homes [40].
- Launching of Bank Muamalat Smart Green Mortgage Solar PV Plan on 1st August 2013, which is the first Islamic Financing Package that supports the HSRP. The finance scheme is expected to support 1000 house owners to fit the homes with solar PV systems at the first year, involving the disbursement of RM 10–15 million [41].

Other than local finance institutions, an electric and electronic retail chain store in Malaysia also introduced a financing package called "Green Energy, Green Money" in August 2013. Other than financial aids (85% of the total cost and 15% cash rebate after full installation), the package also offers consultation, installation and maintenance of PV system to the customers (free service in first 3 years) [42]. This provides Malaysian with more options to involve in the solar energy investments without the need of undergoing application procedures in order to get the loan from the banks.

7. Current solar energy potential

The Sun, being the center of our solar system, provides enormous amount of energy to the Earth. The average incoming energy from the Sun to the Earth is 342 W/m^2. 57% of this energy, which is 198 W/m^2, reaches the Earth's surface, while others are either reflected to space or absorbed by the atmosphere [43]. If the solar energy can be fully harnessed, consumers could obtain the required energy for a year in just 1 h and 25 min from the Sun (according to annual energy consumption in 2008) [43]. As shown in Fig. 4, the annual solar energy that reaches the Earth far exceeds the sum of major energy sources consumption on the Earth in 2012. Thus, solar energy can serve as a major RE source in the future, as long as efficient technology can be developed to harness the solar energy. Although short term changes in the solar irradiance were observed related to the 11-year sunspot cycle, its value is very small, about 1.3 W/m^2 [43]. Long term changes related to astronomical cycles takes the time of millennium to produce observable variations in solar irradiance. Therefore, the average value of solar irradiance on earth can be considered to be constant. However, the local climate and weather produce more noticeable changes to the solar energy received at a particular region.

The application of solar photovoltaic (PV) began in 1970s, and the first commercial concentrating solar power (CSP) plant operated in California from 1984 to 1991 [45]. However, the development of PV technology only started in 1990s, when various countries introduced

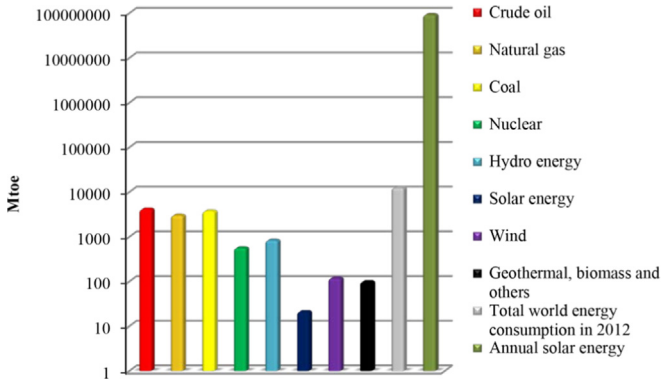

Fig. 4. Comparison of energy consumption at 2012 with annual solar energy that reaches Earth [44].

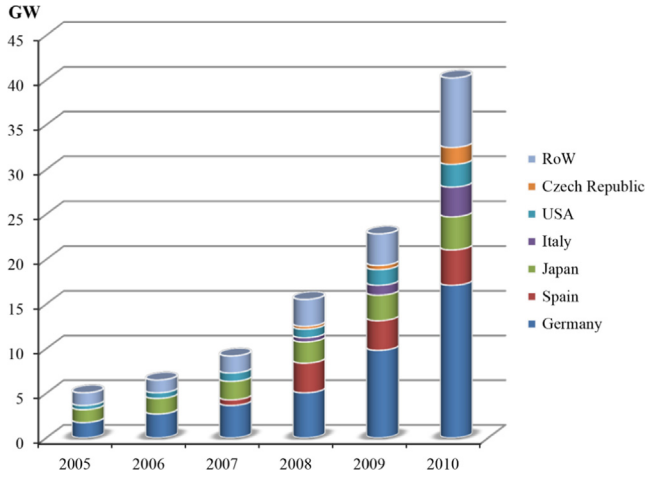

Fig. 5. Global installed capacity of solar PV from 2005 to 2010 [47].

incentives to support it. The supports included 70, 000 solar roof program in Japan in 1995, and 100,000 solar roof program in German in 1999 [46]. Due to the encouraging policy in these countries, solar energy is the fastest-growing RE worldwide, as shown in Fig. 5 [47]. At the end of 2010, there is a total capacity of roughly 40 GW of solar PV installed on Earth, with Germany maintained its massive market lead [47]. The boom of solar PV market is also due to rapid decline of PV costs in the last three decades, as shown in Fig. 6 [48]. A learning rate of 19.3% was recorded, which means that there is a cost reduction of 19.3% for every capacity doubling [48]. This trend is expected to continue, following the development and improvement in the PV manufacturing process. It is expected that the PV will be cost competitive to retail electricity price in some markets soon, and by 2030, it will be competitive with the wholesale electricity price [48].

Energy technology perspective (ETP) by IEA in 2010 [3] describes a BLUE Hi-Gen scenario, where solar electricity will be

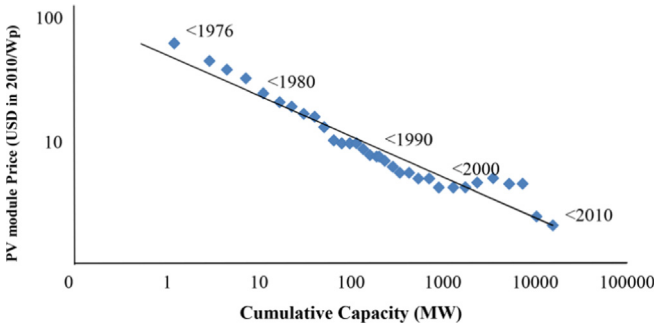

Fig. 6. Cost degression of solar PV modules, 1976–2010 [48].

the largest of all electricity sources, and contribute to 25% of global energy production. The world now is working on solar energy as the main alternative in power generation in the future. It is estimated that there is a total capacity of 30 GW of solar PV being installed globally in 2012. The progress is accelerated by the encouraging policies towards the development of solar energy, especially in Japan and China. In addition, the rapid decline of solar PV generation costs also contributes to the technology blooming. Currently, the mini-grid and off-grid solar PV systems are competitive enough with other electricity alternatives, while some time is required for the small-scale solar PV systems to be competitive with others [2].

According to a study on sunlight measurement [49], it was found that the annual energy output for selected Malaysian cities ranges from 1170 to 1600 kW h/kWp for roof-top systems, and 630–839 kW h/kWp for façade systems. When compared to 41 cities from 26 countries, the average annual energy output of roof top PV system from cities in Malaysia is among the top half for the roof-top solar panel systems. On the other hand, the average annual energy output of façade system in Malaysia lies in the mid-range. With this amount of sunlight, the payback times for the two mentioned systems are expected to be 1.6–2.2 years and 3–4 years, respectively. However, since Malaysian government started the effort in promoting RE sector, the focus has been put mainly on the biomass, biogas and mini-hydro projects. On the other hand, solar energy projects hardly proceeded despite of its potential in Malaysia.

In order to promote the solar energy systems application in Malaysia, Malaysia Building Integrated Photovoltaic (MBIPV) Technology Application Project was launched in July 2005 to 2010, with the objective to reduce the long-term cost of BIPV technology application through widespread and sustainable BIPV development market. When it ended in 2010, the following objectives were achieved:

1. 539% increase in BIPV installed capacity against baseline (instead of 330%, the initial target);
2. 50% reduction of BIPV system unit cost from baseline (instead of 20%, the initial target), and;
3. Introduction of FiT incentive in 10th Malaysian Plan after MBIPV Project.

During the MBIPV Project, Suria 1000 Program was launched to encourage the house owners and companies to install BIPV systems by awarding grants through a bidding system. Due to MBIPV project, Malaysia had roughly 12.6 MW of total PV installment at the end of 2010, of which 1.6 MW were connected to grid [50]. It is also worth noticed that the Malaysian government is still encouraging the development and application of solar PV system after MBIPV Project. This is in accordance with the target of 18,700 MW by 2050 [32]. Solar Home Rooftop Program (SHRP) was launched by SEDA Malaysia on 24th September 2012 to boost the public participation in RE generation. Through this program, Malaysians can participate in the RE as individuals. At the end of April 2013, a total of 14.63 MW was approved in the form of 1079 Feed-in Approvals (FiA) application for individuals [40]. The number rose to 1316 applications with the total capacity of 16.64 MW [41] at the end of August 2013. According to the latest research, the average cost to develop a 4 kW solar PV system is RM 40,000, and it is expected to produce monthly income of RM 500–600 for 21 years, or in total of RM 126,000–151,200. During the period of SREP program, the development of solar PV system was far behind the target. Thus, several steps are currently being taken to ensure the PV system is developed according to the target. One of the steps is to encourage individuals in Malaysia to install the solar panels on the rooftop of their houses. In order to introduce Malaysian to the concept of energy generation in buildings, several showcases of energy-efficient buildings have been built, as listed in Table 6. These buildings demonstrated the feasibility of high energy efficiency, combined with RE generation from the building itself. It is worthy to note that solar PV system is the only RE that can be developed by individuals, while other sources of RE have to be developed by companies.

Malaysians' perspective towards the solar energy development is also important to make FiT mechanism a success, especially in the field of solar PV harvesting. Muhammad-Sukki et al. [9] calculated the possible profit by a Malaysian when investing in rooftop solar energy panels in 2010. The calculation showed that although there was profit from the investment, it was considered small when compared to other investment options available in Malaysia. There is only one case where the profit is comparable to that of Employee Provident Fund (EPF) scheme, which is when the solar panel of <4 kW is installed at the place with highest solar insolation (1900 kW h/m^2). The payback period claimed by SEDA Malaysia for such technology is 7.2 years [51], while according to Muhammad-Sukki, it would be 5.99–12.49 years, depending on various parameters used. Therefore, it is possible that investors will turn to existing investment options instead of solar energy. In addition, it was also shown that most Malaysians were not aware of the incentives from the government, and did not choose to invest in FiT scheme. Among the respondents that agreed to install the solar PV systems, 77% changed their mind after knowing the installation cost (RM 50,000–RM 150,000). Although they understood that they will be provided with bank loans, the uncertainty of technology and existing debts on the respondents acted as the barrier towards the investment [9]. However, SEDA Malaysia played its part to educate the public on the solar PV system and its potentials in Malaysia in these 3 years. Besides, the decrease of initial cost in solar PV system becomes a contributing factor of Malaysians' investment in solar PV systems.

Table 6
Showcases of energy-efficient buildings.

Building	Year completed and location (in Malaysia)	Building energy index (kW h/m^2)	CO_2 reduction (%)
Low Energy Office	2004, Putrajaya	100	56
Green Energy Office	2007, Bandar Baru Bangi	65	86
Diamond Building	2009, Putrajaya	85	65

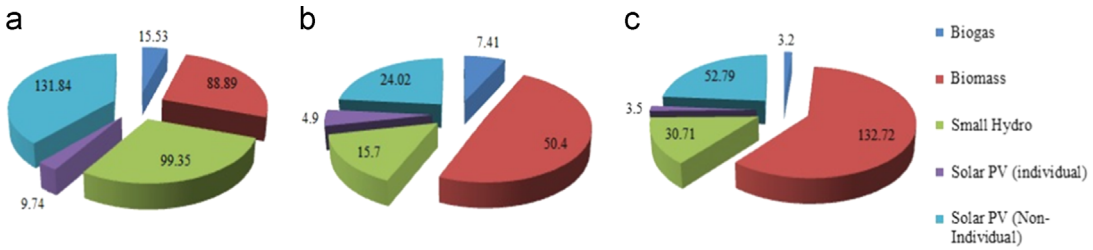

Fig. 7. Installed capacities of Feed-in Approvals up to 30 April 2013 [29].

Table 7
Feed-in Approval Holders in FiT mechanism in 2013 (*Source*: SEDA Malaysia).

Sector	FiAH holder	State	Capacity (MW)	Commencement date
Biogas	Bell Eco Power Sdn. Bhd.	Johor	2.0	Nov 2012
	Biopower Climate Care Sdn Bhd.	Pahang	2.12	Dec 2012
	Achi Jaya Plantations Sdn Bhd	Johor	1.25	Feb 2013
	Felda Palm Industries Sdn Bhd	N. Sembilan	1.1	May 2013
	IOI Biofuel Sdn Bhd	Johor	2.8	Sep 2013
	Jeng Huat (Bahau) Realty Sdn Bhd	Pahang	1.2	Dec 2013
	Magenko Renewables (Penang) Sdn Bhd	P. Pinang	2.4	Dec 2014
Bio gas (landfill/sewage)	Cypark Suria (Pajam) Sdn Bhd	N. Sembilan	1.0	May 2012
	KUB-Berjaya Energy Sdn Bhd	Selangor	1.2	Jun 2012
	Jana Landfill Sdn Bhd	Selangor	1.9572	Jun 2012
	Gaya Dunia Sdn Bhd	N. Sembilan	0.5	Jun 2012
	Gaya Dunia Sdn Bhd	N. Sembilan	0.5	Oct 2012
	KUB-Berjaya Sdn Bhd	Selangor	3.2	Dec 2012
	Bumi Masyhur Industri Sdn Bhd	Melaka	2.0	Jan 2013
	Jana Landfill Sdn Bhd	Selangor	1.0	Jan 2013
	Cypark Suria (Pajam) Sdn Bhd	N Sembilan	1.0	Jan 2013
	Magenko Renewables (Ipoh) Sdn Bhd	Perak	1.2	May 2014
Biomass	Kina Biopower Sdn Bhd	Sabah	11.5	Apr 2012
	Seguntor Bioenergy Sdn Bhd	Sabah	13.4	Apr 2012
	TSH Bio-Energy Sdn Bhd	Sabah	12.0	Jul 2012
	Sunquest Sdn Bhd	N. Sembilan	6.5	Oct 2012
	FTJ Bio Power Sdn Bhd	Pahang	12.5	Dec 2012
	Maju Intan Biomass Energy Sdn Bhd	Perak	12.5	Apr 2013
	Garisan Etika (M) Sdn Bhd	Johor	12.5	Jun 2013
	MHES Asia Sdn Bhd	N. Sembilan	12.0	Jul 2013
	IRM Solar Sdn Bhd	Perak	4.0	Aug 2013
	Tenaga Sulpom Sdn Bhd	Selangor	7.0	Dec 2013
	Agni Power Sdn Bhd	Pahang	4.0	Feb 2014
	Bell Eco Power	Johor	11.0	Jul 2014
	Biofuel Energy Resources Sdn Bhd	Selangor	6.0	Nov 2014
Biomass (solid waste)	Recycle Energy Sdn Bhd	Selangor	8.9	Jun 2012
	Future NRG Sdn Bhd	N. Sembilan	1.893	Mac 2014
	Biofuel Energy Resources Sdn Bhd	Selangor	7.0	Dec 2014
Small hydro	Amcorp Pertinf Hydro Sdn Bhd	Pahang	4.0	Jun 2012
	Renewable Power Sdn Bhd	Selangor	2.0	Jun 2012
	Esajadipower Sdn Bhd	Sabah	4.5	Jun 2012
	Esajadipower Sdn Bhd	Sabah	2.0	Jun 2012
	I.S. Energy Sdn Bhd	Kelantan	3.2	Dec 1012
	Pesaka Technologies Sdn Bhd	Kelantan	12.0	Mac 2013
	C Two Energy Sdn Bhd	Terengganu	2.3	Dec 2013
	Kerian Energy Sdn Bhd	Perak	12.0	Dec 2013
	Sumber Sejahtera Sdn Bhd	Perak	10.0	Apr 2014
	Selama Hidro Sdn Bhd	Perak	13.8	Apr 2014
	Pasdec Mega Sdn Bhd	Pahang	5.0	Jun 2014
	Kuasa Sezaman Sdn Bhd	Perak	7.0	Jun 2014
	Sumbangan Sakti Sdn Bhd	Pahang	2.0	Jun 2014
	Zeqna Corporation Sdn Bhd	Perak	6.0	Nov 2014
	Koridor Mentari Sdn Bhd	Perak	5.25	Nov 2014
	Conso Hydro R E Sdn Bhd	Perak	2.0	Jan 2015
	JMT Kelantan Baru Sdn Bhd	Kelantan	20.0	Jun 2015

8. Progress of RE development in Malaysia

With reference to Fig. 7, up to April 2013, RE Projects that have been approved equaled to the capacity of 345.35 MW, and 102.43 MW from the figure is currently being exported to the grid from the operating facilities. A total of 91,874.46 t of CO_2 reduction was recorded in 2012, and this figure is expected to achieve 220,174.86 t in 2013 [29]. The companies that are currently holding

Table 8
FiAH in solar PV sector. (*Source*: SEDA Malaysia).

Solar PV	Number of FiAH
Individuals	1590
Non-individuals	
≤ **500 kW**	186
≥ **500 kW**	59

the Feed-in Approvals in numerous sectors are listed in Table 7. Active participation of individuals in the generation of solar energy is observed, as the amount of FiA reached 1590, as shown in Table 8. This shows that efforts by SEDA Malaysia successfully attracted Malaysian's interest in the solar energy investment.

9. Conclusion

The enactment of Renewable Energy Act 2011, together with the establishment of Sustainable Energy Development Authority (SEDA) provided solutions to shortcomings identified during the period of SPRE Program, which include the capacity capping, low tariffs, as well as effort- and time-consuming procedures involving the developers, utilities, government bodies and agencies. This has greatly improved the prospect of the RE field, especially for solar energy. The recent blooming of solar PV panel installments in Malaysia is also contributed by the efforts from the business and banking sector. It is then reasonable to predict that Malaysia will be able to reduce the overreliance on fossil fuel in electricity generation with the renewable energy mix.

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